

INTELLIGENT CASE HISTORY TAKER

A COMPUTER PROGRAM FOR REFERRAL IN PRIMARY HEALTH CARE

Introduction :

Medical uses of computers can be grouped into :

1. Data storage, retrieval and statistical analyses
2. Decision making

This is an attempt to incorporate decision making for a high risk area like children under 5 years of age. Different approaches to decision making programs are :

1. Algorithmic - using flowcharts
For example, ICU management.
2. Automatic Interpretations - with clinical measurements
For example, ECG.
3. Actuarial - risk evaluation with "cheap data"
For example, cardiac parameters.
4. Advice Systems or "Expert Systems" - explicit modelling of medical knowledge in Artificial Intelligence (AI) terms by data-driven or goal-driven programs.

Our effort involves all these methodologies, but mainly the AI approach & identifying highrisk in the population.

The problems of computerisation are well known, and must be overcome. Reliability, design, standardization and maintenance of routines and proving the benefits are all planned.

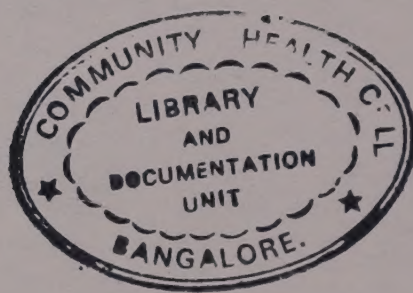
We have targetted the 0-5 years age group for the following reasons :

1. This is a highly vulnerable population, with a high mortality of Under 5 Mortality Rate of 140 per 1000 live births. With 240 million children in India and 30% of all deaths in the world, it is necessary to address this problem on a war-footing.
2. Causes of mortality and morbidity are easily identified. High risk areas of malnutrition, diarrhoea, ARI, Vaccine-preventable disorders, etc contribute to more than 80% of mortality and morbidity.
3. Simple measures are available to reduce this burden to practically well below Under 5 MR of 50, with

Growth Monitoring
Oral Rehydration
Breast Feeding
Immunisation
Feeding Supplements
Family Spacing
Female Education

GOBIFF
PLUS

ARI Programs
Neo-natal Care
Safe Water
Sanitation
Curative Services for
simple illnesses/injury



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4. However, it is not easy to implement these, unless high risk groups of lower socio-economic groups, villages, slums etc. are effectively covered.

Existing, tried-out programs :

- 1. Primary health centres with package of services developed over 50 years.
- 2. Well-Baby clinics gave way to Under 5 Clinics in developing nations including curative, family, nutritional and health promotional aspects together.
- 3. Specific high risk oriented programmes:
Family Planning, Nutritional Programmes, Vitamin A Prophylaxis, Immunization (EPI, UIP, NIM), Diarrhoea Control Programme, ARI Programme etc.
- 4. Community based package of service programmes:
ICDS, CSSM : put all the previous programmes into co-ordinated programmes.

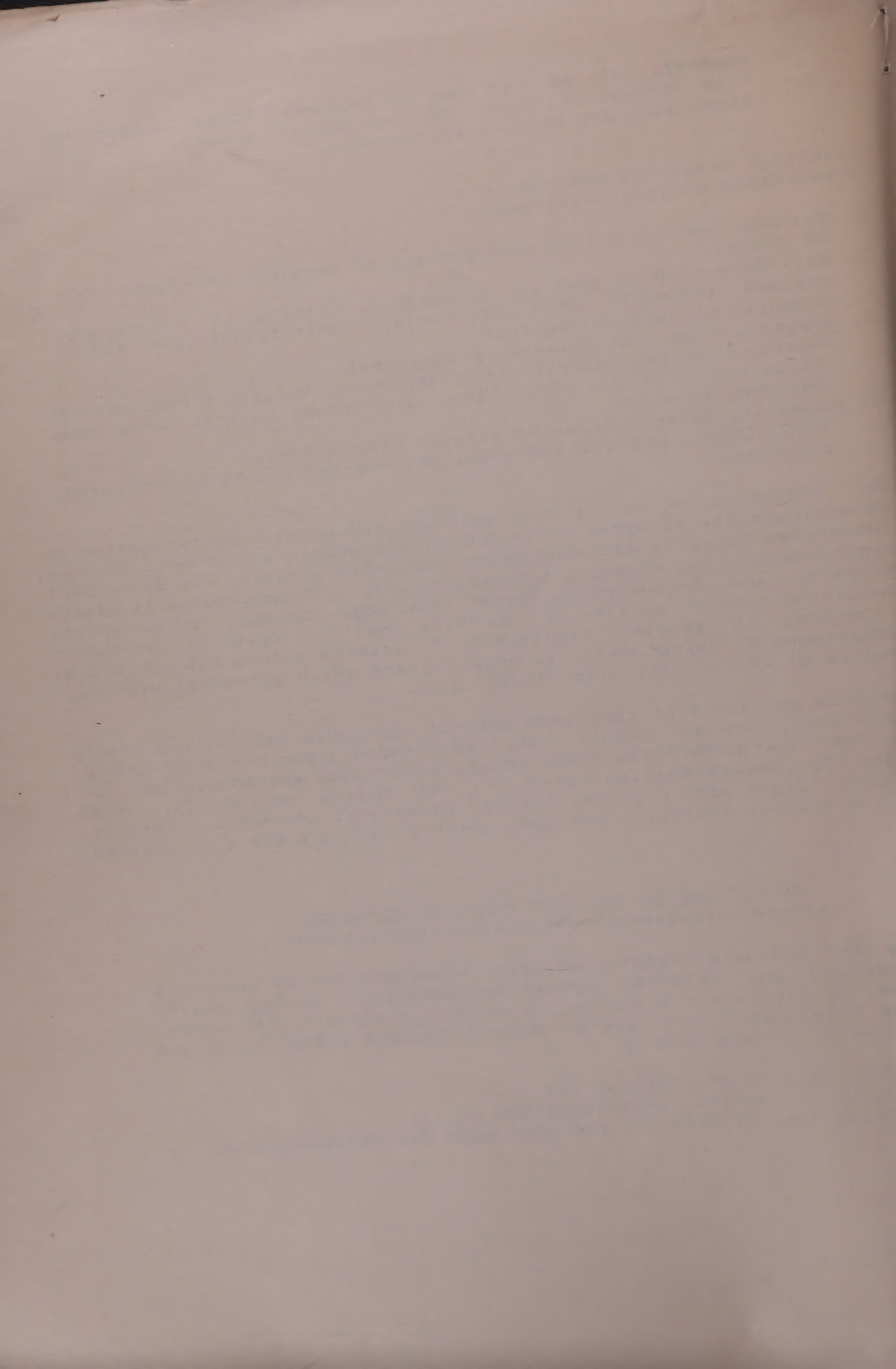
Our effort is to use the same methods, but using computerisation to co-ordinate the services better. Our role models are Under 5 Clinics, Integrated Child Development Services, Child Survival and Safe Model programmes, using existing services of PHC's, Community Level Health workers and Anganwadi's. Being knowledge based, risk-oriented, involving simple skills to identify maximum coverage to common illnesses, it is also highly result oriented. This has additional advantages of being useful to organize and train personnel with high degree of effectivity with flexibility.

Critics may say that computers are not available easily, are highly technical, require highly skilled personnel and are error-prone. We feel that proper planning, trial, experience and adaptation can make the computerisation "do-able". We intend to do it, with sound logic and clinical trials, to make it feasible. Further, field trials, logistics and cost/benefit analysis are also planned.

AN OUTLINE OF THE ICHT COMPUTER SOFTWARE

The ICHT software provides an ideal framework for developing a screening and referral system for paediatric primary health care. We envisage a scenario in which a primary health worker uses this system as an aid to collect patient informations and arrive at actions such as

- 1. Rush to a major hospital for
- 2. Refer for further investigations of ...
- 3. Treat locally with ... and come back for re-assessment.



The system not only advises on the current complaints, but also monitors parameters such as growth, milestones, immunization status etc.

Since the system is intended to be used by primary health worker, the software has to meet the following basic requirements:

1. The system must suggest to the health worker, a 'suitable' question for asking the patient at each step.
2. The system must use the response to arrive at conclusions and/or suspect a possibility, and add more topics to explore.

In general, the system must perform "intelligent" questioning.

The Nodal Centre on Expert Systems at IIT, Madras, have designed and implemented such a software in collaboration with the Paediatrics Department, St. John's Medical College Hospital, Bangalore.

In simple terms, ICHT is a knowledge based computer system, that uses a hybrid representation of FRAMES and RULES to model medical knowledge. Symptoms are modelled as frames, and their characteristics are modelled as slots. Rules capture the logic involved in the evaluation of the truth value of disease expressions.

By and large, the problems of conceptual design for a referral system have been resolved. At this stage of the project, a prototype version is being tested. Based on the feedback, the system will be refined to extend coverage and to make it more robust and user-friendly.

A computer based referral system will go a long way, in ushering a new era of health care in a developing country, like India.

EVOLUTION OF THE FORMAT

Ideally every village should have a paediatrician, but this is an impossibility in the current situation. Alternatively, Health Workers can be given the essential paediatric knowledge and take over the functions of the paediatrician to some extent. The functions of such a paediatrically oriented Health Worker in an Indian village should include the following:

- * Elicit a systematic history
- * Classify diseases according to severity
- * Make a preliminary diagnosis
- * Initiate treatment
- * Refer cases according to urgency

- * Follow up the therapy initiated
- * Monitor growth, development, nutrition and immunisation status
- * Administer prophylactic medications
- * Educate mothers on nutrition, breast feeding and spacing of the family
- * Schedule subsequent visits
- * Take part in the development of a healthy environment

These functions can be carried out by a computer guided system after minimal training of a Health Worker.

Thus our attempt is to incorporate the preventive, promotive and curative aspects of pediatric health care in a computer guided system which would enable a primary healthworker to function optimally in the village, with minimal supervision by the doctors at PHC or higher levels.

This would demystify, the progressively alienated technological system of modern medicine, to the common man.

A knowledge based computer system will assist

- * in collecting and compiling data and retrieving it whenever necessary
- * develop systems in identifying, notifying and warning of outbreaks of communicable diseases
- * to assess disease prevalence in an area and modify the program suitably.
- * get assistance on line from higher centres
- * help reducing health budget and to improve quality of life
- * help in teaching and training programmes

Hence our aim is to

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*
*   DEVELOP A COMPUTER GUIDED SYSTEM FOR PRIMARY HEALTH
*   CARE, SCREENING AND REFERRAL OF UNDER 5 CHILDREN.
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MATERIALS AND METHODS:

A format has evolved through repeated trials. Initially, consultants used the format in patient evaluation and concurrently altered and modified it, depending on the defects detected. Subsequently untrained nurses used it to identify diseases. The inference reached was compared to that suggested by the OPD doctors.

This format was used by the 1st year nursing students after a brief training. The result obtained by comparing the final advice derived through the format with that of the OPD showed 97% concordance. The format also detected additional points in monitoring aspects.

The lapses of the format detected were classified into three :

1. Those correctable by training.
For eg, assesing degree of dehydration.
2. Those correctable by proforma modification.
For eg, new algorithm for abdominal pain.
3. Those beyond the scope of the format.
For eg, Splenomegaly.

Simultaneous computerisation and further modification of the format is made and the final format is being used for evaluation of the OPD patients. Currently, the validation of the format is done by non medical personnel after 7 days of training. The details of the validation will be discussed later.

STRUCTURE AND LOGIC OF THE FORMAT:

Our program is intended to serve the under five children through primary health care screening and referral by a computerized approach. With these objectives, a format is evolved with simple questionnaires to elicit the symptoms and signs. The format is suited for non medical personnel with 10th standard education, who with 2-3 weeks training could evaluate a patient to arrive at a meaningful action plan. The whole format is structured into three areas:

1. Common presenting Complaints.
 - A. Cough - ARI adapted with modification, Duration > 14 days, Yellow discharge from nose, Night Cough, Wheeze, Recording of level of consciousness
 - B. Fever
 - C. Convulsions
 - D. Diarrhoea - adapted from Diarrhoea Control Programme
 - X. Other complaints
2. Risk factors in
 - E. Past history
 - F. Family and neonatal history
3. Health monitoring and specific protection
 - G. Growth
 - H. Development
 - I. Immunisation
 - N. Nutrition

Total questions generated by the computer/format is 106 and on an average, 50 questions are asked to each patient. The total duration required per a patient is less than 10 minutes. The responses to all questions are YES/NO and there are a few items only for documentation.

Each positive response, derives a diagnostic risk factor or severity of the illness. This automatically triggers an action plan for each factor.

Codes are created to computerize and to summarize. Each question has got three codes:

1. The Symptom code
2. The Inference code or the Severity code
3. The action code.

The action or advice depends upon the particular symptom as well as the inference or severity of the illness. Severity is graded as mild (L), moderate (M), severe (S) and very severe (V).

Patients with severe and very severe illnesses are referred urgently or immediately. Another category "Refer for further investigations" is included to cover chronic cough, persistent fever and the groups which include the mandatory questions of past history, family history, growth, milestones, immunisation and nutrition. Hence the logic behind each question to arrive at an inference and a definite action are to be explained. The scientific medical explanations are grouped into three categories:

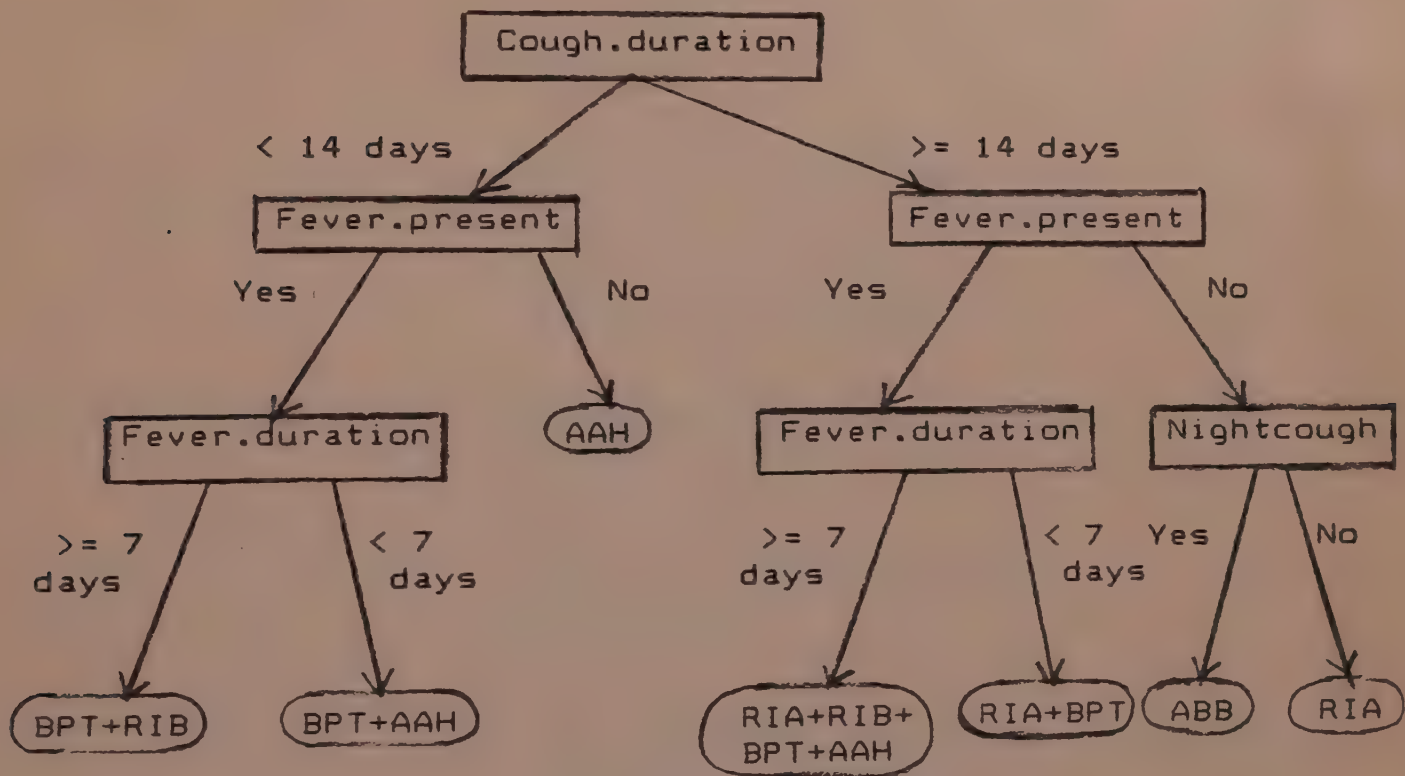
1. Standard reference.
2. Common practice.
3. Our personal experience.

Section of Cough and Cold is covered in detail to explain the logic.

Cough and Cold

In this section as in ARI national programme pneumonias are given the priority. Some of the major changes made with respect to ARI programme are Starting antihistaminics for cough, Treating Persistent night cough and wheeze with bronchodilators, Treating infected nasal discharge with antibiotics, Documentation of duration of cough and level of consciousness and Referring cases of Chronic cough.

ALGORITHMIC APPROACH - An Example



ACTION CODES

- BPT : Paracetamol for fever
RIB : Refer for investigation of persistent fever
AAH : Antihistaminics for cough
RIA : Refer for investigation of chronic cough
ABB : Bronchodilators for wheeze

The following are some examples of logic with source of knowledge indicated by symbols:

- Standard references : Action code underlined as -----
Common practices : Action code underlined as *****
Our personal experiences : Action code underlined as ++++++

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A. COUGH

| ***** | | | |
|---------------------------------|---------------|---|--------------|
| Symptom/Sign | Severity Code | Explanation | Action Code |
| ***** | | | |
| Cough Duration... | AL | Common practice to use antihistaminics to control cough | AAH ----- |
| Cough > 14 days | AM | Persistent night cough: Treat with bronchodilators. | ABB +++++ |
| | | Other chronic coughs: Refer for investigations | RIA ***** |
| Wheeze | AM | Bronchodilators are used to control wheeze | ABB ***** |
| Yellowish nasal discharge | AM | Common practice to treat bacterial infections with antibiotics | AAT ----- |
| R.R > 50/mt | AM | Fast breathing is a sensitive indicator of presence of pneumonia in infants in the age group of 2-11 months | AMP ***** |
| Chest Indrawing | AS | Indicates severe pneumonia | URP ***** |
| Stridor | AV | Indicates a very serious illness | IRS ***** |
| Unable to drink or feed | AV | Indicates a very serious illness | IRF ***** |
| Convulsion | AV | Indicates a very serious illness | IRC ***** |
| Too sleepy or difficult to wake | AV | Indicates a very serious illness | IRL ***** |

Other standard symptoms analysed, follow along with the main purposes of the questionnaire.

B. FEVER

In this section, common illnesses like viral fever, acute ear infection, throat infection, exanthematous illnesses like chicken pox, measles, etc are given treatment. Serious illnesses like persistent fever, arthritis, meningitis, diphtheria, hepatitis, urinary tract infection and other serious illnesses are detected and referred.

C. CONVULSIONS

In convulsions, treatment is planned for a convulsing patient and also for febrile convulsions. All patients with convulsions (except the febrile convulsions) are referred according to the severity.

D. DIARRHOEA

The current format is according to DCP, the Diarrhoea Control Programme, and not as per DTTU. It also identifies chronic diarrhoea (duration > 14 days), dysentery (blood and mucus) and cholera (rice water stools).

- Different grades of dehydration are assessed as mild, moderate or severe; and ORS is advised accordingly.
- Antibiotics used for dysentery, cholera and diarrhoea associated with fever of 5 days.
- Referred for investigations in case of chronic diarrhoea and urgently referred for severe dehydration.
- Symptoms of helminthiasis is included in this section, and deworming advised in symptomatic cases.

X. OTHERS

In this section, common skin infections like pyoderma are included and treated with local antibacterial drugs, scabies with benzyl benzoate.

Other complaints like abdominal pain, severe pallor, birth defects, dysmorphism, jaundice, painful restriction or weakness of any limb, swelling, accidents, foreign body, poisoning are considered and referred after first aid measures if necessary.

This section is likely to be expanded depending upon the cases prevalent in the community.

Slots for documentation of other significant finding on examination and investigation available with the patient are given.

E. PAST HISTORY

Here past history of similar complaints, any hospitalisation and other relevant history are recorded. History of recurrent illness is given a definite action plan of referring for further investigations when associated with grade 2 or more malnutrition. Surprisingly this has already picked up chronic cases like congenital heart diseases and pulmonary tuberculosis which manifest with recurrent respiratory infections and failure to thrive.

A referral to rule out tuberculosis is given, when there is contact with tuberculosis or when there is history of pertussis/measles with no BCG vaccination.

F. FAMILY HISTORY

This highlights the risk factors by documenting consanguinity, obstetric history and also neo-natal history of birth asphyxia, birth weight, jaundice and convulsions. Neo-natal history, when associated with delay in two or more recent milestones, the patient is referred to confirm/rule out cerebral palsy, metabolic disorders or intra-uterine infection. This has also successfully picked out cases of cerebral palsy and intra-uterine infections.

G. GROWTH

Here, a graphical interface is used to record the current weight of the child (in kilograms). The grades of malnutrition are arrived at automatically. Also edema, mid-arm circumference and height are noted. Appropriate actions are suggested for marasmus, kwashiorkor, and other grades of malnutrition.

H. MILESTONES

Twelve questions to include motor, mental, social milestones including teething, anterior fontanelle closure and speech are incorporated. A patient will be referred if two or more recent milestones are delayed.

I. IMMUNIZATION

This follows the UIP schedule, except for MMR. General advice regarding the administration of vaccines are given after taking contra-indications into account. Minor illnesses like fever, cough or diarrhoea do not postpone the immunization schedule.

N. NUTRITION

Nutritional advice includes breast feeding upto 4-6 months, and then starting semi-solids, encouraging home diet and discouraging bottle feeds. Regular deworming every six months in rural areas and Vitamin A prophylaxis are also incorporated.

These questionnaires are not final, and need constant reviewing to correct the mistakes which might be in the format/training, or to identify those which might be beyond the scope of this programme, with changing pattern of diseases. Hence, logic and training will be continuously monitored and changed to maintain effectiveness. Feedback from online trials, will make this feasible to produce improved versions. The entire programme is intended to be used under medical supervision.

DATA FORMAT VALIDATION AND RELIABILITY INDICES

This computer software format has been designed to assist a primary health worker to decide about treating five major childhood problems which can significantly alter the mortality of Under 5 children and identify other common risk factors.

For statistical evaluation, the following assumptions are made. Firstly the program is considered as a screening tool, for decision making both for system involved and for severity of disease, so that appropriate action could be taken. The biases inherent in hospital based study are also accepted but are probably not interfering with the results as it is a preliminary test leading to field trials for confirmation.

This proforma is intended for use by a primary health worker with atleast tenth standard education level, hence this has to be validated later at that level.

LAPSE ERRORS

| PROFORMA ERRORS | TRAINING ERRORS | BEYOND SCOPE |
|--|---|----------------------------------|
| 1. Abd. pain - 2 cases (corrected) | 1. H/o Measles - 1 case chicken pox | 1. Mass abdomen, Splenomegaly |
| 2. Vomiting - 1 case (corrected) | 2. H/o Febrile - 1 case convulsions without fever was referred | |
| 3. H/o Medication on ATT/ To continue - 1 case | 3. Chest indrawing Wrong - 2 cases interpretation | |
| 4. Diarrhoea - 1 case severity (corrected) | 4. Large watery - 1 case stools considered rice watery | |
| 5. H/o fever - 1 case 6 months | 5. Dehydration - 1 case assessment wrong | |
| | 6. Chicken pox - 1 case referred as fever with rash | |

ADDITIONAL POINTS FROM FORMAT (not picked up in the OPD):

1. Deworming
2. Immunization advice
3. Grade II malnutrition detected
4. Bronchodilator use in wheeze
5. Antibiotics in infected nasal discharge

OPD ERRORS:

1. Antibiotics started (viral fever).
2. Severe pneumonia considered moderate.
3. Severe pneumonia with wheeze considered HAAD with no antibiotic.

CONCLUSIONS

With this data it is clear that the knowledge and logic in the program is well on the process of validation and we are in a position to maintain continual supervision and revision as needed. The logistics of paramedical personnel participating in the action and/or referral system is also conceptualised. However, we have to organise field trials to develop the program to its full scope. In order to make it a standard tool, we still need to work on logistics, costs and benefits.

After the successful trial and production of the software, we visualise much broader avenues for the future. The software has good potential as a permanent patient record for use at the periphery, PHC referral centres as well as higher centres. With compilation of case materials together in large numbers, this can become a valuable teaching and training aid for the health workers. If the software is used extensively, it is also a source of database for meaningful analysis by the health authorities. One can even visualise a regional network for better patient care, data mobilisation, instant consultation, disease surveillance for epidemics and reorganisation of regional health services.

We are looking well ahead beyond 2000 A.D., when the use of computers is universal at all levels of the society. Considering this, we are very optimistic that this program is a significant contribution to improve the health of Under 5 children in India and other developing countries.

A TYPICAL DIALOGUE WITH THE EXISTING SYSTEM

* DIALOGUE *

Q : Give Child's name ?

A : Bharath

Q : What is the child's sex ?

A : male

Q : Give Child's date of birth(dd/mm/yyyy) ?

A : 01011990

Q : Give child's birth weight in kg ?

A : 2

Q : Give the name of the Informant ?

A : Mother

Q : What is the duration of fever (in days) ?

A : 5

Q : What is the temperature (in degree fahrenheit) ?

A : 100

Q : Does the child have ear discharge?

A : no

Q : Does the child have yellow discoloration of eyes or skin ?

A : no

Q : Does the child have burning urination ?

A : no

Q : Does the child have throat pain and difficulty in swallowing ?

A : yes

Q : Is the throat congested ?

A : yes

Q : Look in the throat. Is there increase in redness or enlarged tonsils ?

A : yes

Q : Look in the throat. Is there any whitish membrane ?

A : no

Q : Does the child have uncontrollable cry ?

A : no

Q : Does the child have joint pains ?

A : no

Q : Does the child get febrile convulsions ?

A : no

Q : What is the duration of cough (in days) ?

A : 3

Q : Does the child have wheeze ?

A : no

Q : Does the child have yellowish discharge or pus from the nose ?

A : yes

Q : What is the respiratory rate (per minute)?

A : 50

Q : Does the child have stridor ?

A : no

Q : Does the child have chest indrawing ?

A : yes

Q : Is the child unable to drink or feed ?

A : no

Q : Did the child have the same problem before ?

A : no

Q : Was the child admitted to a hospital before ?

A : no

Q : Does the child get recurrent illness ?

A : no

Q : Did the child have any contact with tuberculosis ?

A : no

Q : Does the child have history of measles ?

A : no

Q : Does the child have history of whooping cough ?

A : no

Q : Does the child have allergy to amoxycillin ?

A : no

Q : Does the child have allergy to cotrimoxazole ?

A : no

Q : Does the child have allergy to furoxone ?

A : no

Q : Record any other significant past history, okay ?

A : no

Q : Are the child's parents from related families ?
A : yes

Q : How many times has the mother conceived ?
A : 2

Q : How many times has the mother had abortions ?
A : 1

Q : How many siblings of the child have died ?
A : 0

Q : Did the child not cry immediately after birth ?
A : no

Q : Does the child have history of jaundice or convulsions in the newborn period ?
A : no

Q : Approximately, when was the child last dewormed ?
A : 0

Q : Approximately, when was the child last given Vit A ?
A : 0

Q : Does the child have vomiting ?
A : no

Q : Is the child too sleepy or difficult to wake ?
A : no

Q : Does the child get convulsions ?
A : no

Q : When did the child start SMILING ?
A : 2

Q : When did the child hold HEAD STRAIGHT first ?
A : 4

Q : When did the child TURN OVER ?
A : 6

Q : When did the child start SITTING w/o support ?
A : 8

Q : When did the child start TEETHING ?
A : 9

Q : When did the child start STANDING UP ?
A : 10

Q : When did the child start WALKING ?
A : 13

Q : When did the child's ANTERIOR FONTANNELE close ?
A : 16

Q : When did the child start saying 3 WORDS ?
A : 14

SUMMARY PRODUCED BY THE EXISTING SYSTEM

* CASE SUMMARY *

Patient ID : 122.

Session on : 20 - 10 - 1992.

Session Report printed at : 15:59 hrs

* PRESENTING COMPLAINT(S) *

FEVER
COUGH

* SUMMARY *

Q : Give Child's name ?

A : Bharath

Q : What is the child's sex ?

A : male

Q : Give Child's date of birth(dd/mm/yyyy) ?

A : 01011990

Q : Give child's birth weight in kg ?

A : 2

Q : Give the name of the Informant ?

A : Mother

Q : What is the duration of fever (in days) ?

A : 5

Q : What is the temperature (in degree fahrenheit) ?

A : 100

Q : Does the child have throat pain and difficulty in swallowing?

A : yes

Q : Is the throat congested ?

A : yes

Q : Look in the throat. Is there increase in redness or enlarged tonsils ?

A : yes

Q : What is the duration of cough (in days) ?
A : 3

Q : Does the child have yellowish discharge or pus from the nose ?
A : yes

Q : What is the respiratory rate (per minute)?
A : 50

Q : Does the child have chest indrawing ?
A : yes

Q : Are the child's parents from related families ?
A : yes

Q : How many times has the mother conceived ?
A : 2

Q : How many times has the mother had abortions ?
A : 1

Q : How many siblings of the child have died ?
A : 0

Q : Approximately, when was the child last dewormed ?
A : 0

Q : Approximately, when was the child last given Vit A ?
A : 0

Q : When did the child start SMILING ?
A : 2

Q : When did the child hold HEAD STRAIGHT first ?
A : 4

Q : When did the child TURN OVER ?
A : 6

Q : When did the child start SITTING w/o support ?
A : 8

Q : When did the child start TEETHING ?
A : 9

Q : When did the child start STANDING UP ?
A : 10

Q : When did the child start WALKING ?
A : 13

Q : When did the child's ANTERIOR FONTANNELE close ?
A : 16

Q : When did the child start saying 3 WORDS ?
A : 14

INSTRUCTION TO HEALTH WORKER :

- 1: Deworm the child after 6 months.
 - 2: Give Vitamin A 2 lakh orally, after 6 months.
-

PRESCRIPTION :

- 1: Give BENADRYL 1 1/2 tsp 3 times a day for 5 days.
(1tsp = 12.5 mg)
 - 2: Give AMOXYCILLIN 1.5 tsp. 3 times a day for 7 days. (1 tsp. = 125mg)
 - 3: Give PARACETAMOL 1/2 tab. 4 times a day.
 - 4: To deworm this child, give MEBENDAZOLE 1 tab. 2 times a day for 3 days.
-

FINAL ADVICE :

Urgently take this child to a district hospital within 6 hrs for :

- 1: Severe pneumonia after giving 1st dose of AMOXYCILLIN.
-

***** END OF REPORT *****

Proposed form of the Case Summary

Bharat (DPD No. 63090), born on 01/01/1990,
was brought on 12-10-1992, by the mother,
with the complaints of

1. Cough of 3 days duration, with
(a) h/o Yellow discharge from the nose
2. Fever of 5 days duration
(a) h/o Difficulty in swallowing

On examination, the child had :

1. Respiratory rate (per min) : 50
2. Chest indrawing
3. Congested throat
4. Enlarged tonsils

Past History : Not significant

Family History :

1. Born to consanguinous parents.
2. No. of abortions : 1
3. Birth weight (in kg) : 2

Growth :

Normal

Development :

Normal

Immunization :

Complete as on date.

Proposed:

- OPV Booster 1 : 23-10-1992
DPT Booster 1 : 23-10-1992

Inference :

This child has

1. Severe Cough
2. Moderate Fever

Message for the Health Worker :

1. Give PARACETAMOL 1/2 tab.
2. Give AMOXICILLIN syrup 7.5 ml.

Prescription : /* In this case nil, so this whole
----- section will not be printed */

Final Advice :

Take this patient to the nearest hospital
within 6 hrs.



